UNIT 9
KIRCHHOFF'S FIRST RULE

(from Lillian C. McDermott and the Physics Education Group, *Physics by Inquiry Volume II, John Wiley and Sons*, NY, 1996)

Objectives

- to understand how to use an ammeter to measure current
- to understand Kirchhoff's First Rule

Equipment:

1 ammeter
8 alligator clips
1 bulb
1 socket
1 30cm nichrome wire
1 60cm nichrome wire
1 90cm nichrome wire
2 45cm nichrome wire
1 battery
1 battery holder
1 switch

1.1 We have been using the brightness of a bulb as an indicator of the amount of current passing through the bulb. In this section we will begin a quantitative analysis of circuits. We will measure the magnitude of current through parts of a circuit with an instrument called an ammeter. We will also quantitatively investigate resistance.

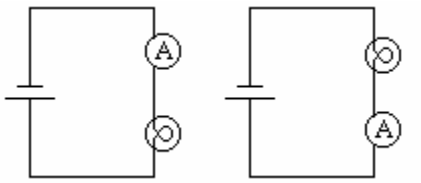
Based on our observations, we have a model for current in which the current is not "used up". Another way of expressing this is to say that current is conserved. We will examine the conservation of current quantitatively

In order to investigate the conservation of current, we will use linear resistors. The linear resistors we will use are pieces of nichrome wire.

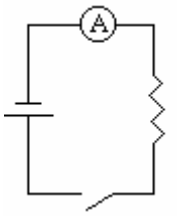
To measure current we will use an ammeter. An ammeter, when connected in series in a circuit, measures the current through the circuit with very little change in the resistance of the circuit.

We have found that it is impossible from our observations to tell the direction of current through the battery. We will follow the widely used convention of assuming that the flow is from the positive terminal of the battery through the circuit to the negative terminal of the battery, and from the negative to the positive terminal within the battery. Ammeters and other electrical instruments should be connected in a circuit in the same sense, with the terminal marked positive closer to the positive end of the battery.

a. Hook up the ammeter in series with the bulb in a single bulb circuit with the positive end of the ammeter closer to the positive terminal of the battery, as in each of the two diagrams below. Record the reading of the current in each case. Are the current readings consistent with your previous observations? Explain. Then take the same readings, with the ammeter leads reversed (with the ammeter connected in the wrong sense). How do the readings with the ammeter connected in the wrong sense, compare to the readings with the ammeter connected in the correct sense?



b. Set up a circuit with a 30cm length of nichrome wire in series with an ammeter, as shown in the picture below, and record the ammeter readings.

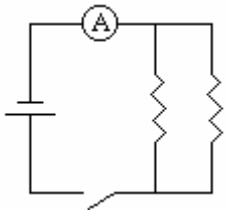


The symbol  represents a resistor.

c. Repeat part **b** with 60cm and 90cm lengths of nichrome wire.

d. Compare the ammeter reading of the 30cm, 60cm, and 90cm lengths of nichrome wire.

1.2 Set up the following circuit with a 30cm length of nichrome wire in each branch.



a. Record the ammeter reading.

b. Disconnect the ammeter and reconnect it to the other side of the parallel network. Record the ammeter reading.

c. Disconnect the ammeter and reconnect it to one of the branches containing a resistor. Record the ammeter reading.

d. Disconnect the ammeter and reconnect it to the other branch containing a resistor. Record the ammeter reading.

e. Repeat parts **a** through **d** with a 30cm length of nichrome wire in one branch and a 60cm of nichrome wire in another branch.

Kirchhoff's First Rule is:

The total current out of a node is equal to the total current into the node.

f. Is this consistent with your data in parts **a** through **e**?

SUMMARY

You should understand how to use an ammeter to measure current. You should understand Kirchhoff's First Rule.